NASA TECH BRIEF

Ames Research Center

Variable Ratio Beam Splitter for Laser Applications

A rugged, versatile, highly efficient, variable ratio beam splitter employing birefringent optics can provide either widely different or precisely equal beam ratios and can be used with laser light source systems, for interferometry of lossy media, holography, scattering measurements, and precise beam ratio applications. The device is similar to one previously described (see Reference).

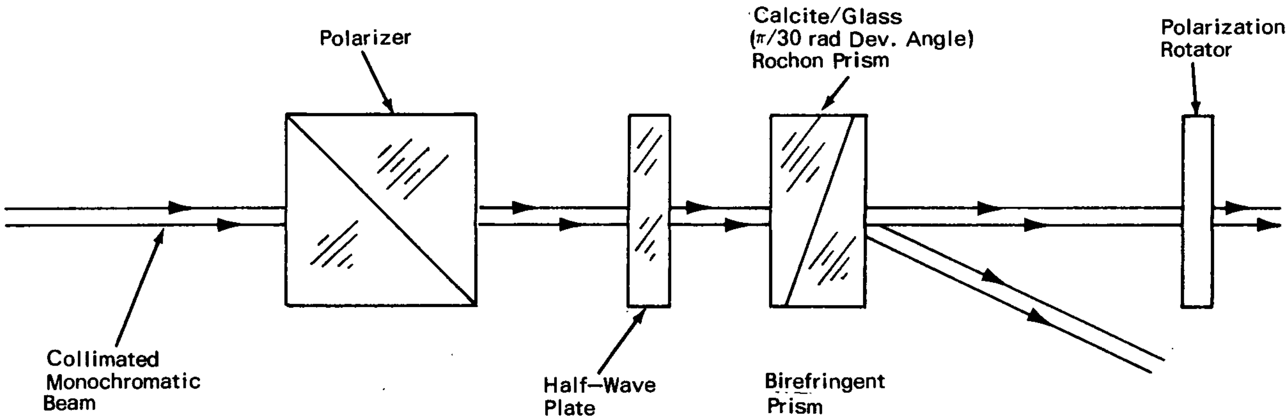

Figure 1. Schematic of Birefringent Beam Splitter

A Glan-Thompson polarizer linearly polarizes the incoming light beam (see Fig. 1) and passes it through a half-wave plate which can be rotated about the optical axis. The plane of the emerging light is rotated by twice the angle, θ, between the incident light polarization plane and the plate's principal axis. The light enters a birefringent prism (a Rochon prism, in this case) which divides it into two orthogonally polarized components whose intensity ratio is equal to $\tan^2 \alpha$, where α is the angle between the polarization plane and the prism's principal axis. As the plate rotates, this intensity ratio continuously changes. For identical beam polarizations, a polarization rotator or a second half-wave plate can be added to one beam.

Because the entering beam must be collimated and monochromatic, the beam splitter is most useful with laser sources. If the beams are already polarized, the device is very efficient because its only inherent losses are caused by surface reflections and intramaterial scattering. Also, the beam splitter can be constructed of air-spaced or optically contacted components, without reflective films, making it highly resistant to high power density damage and possibly usable with Q-switched ruby lasers.

The device was employed in a less-than-optimum

(continued overleaf)

arrangement (see Fig. 2) to examine its practical usefulness. No polarizer was used, an SiO-overcoated aluminum mirror was placed in the path, and only standard precautions were taken to ensure optical surface cleanness. A PIN photodiode detector, for measuring the light intensity of each beam, was inserted alternately in the two beams and adjusted for maximum signal. Because the intensity of the unattenuated laser light was too strong for the detector, an attenuator suitable for coherent light beam use was needed.

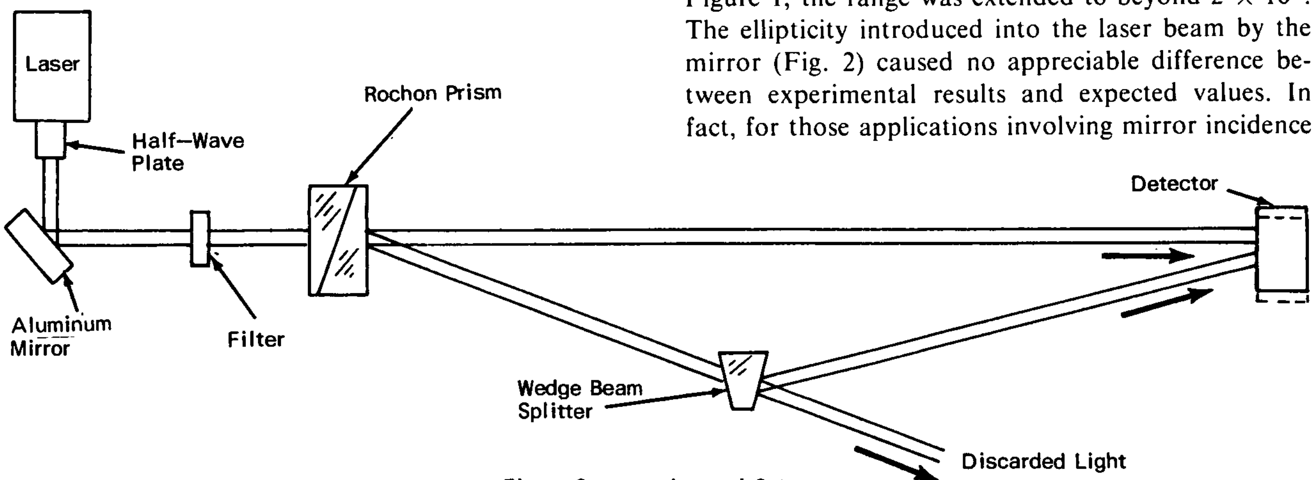

Figure 2. Experimental Setup

A photographic neutral density filter was tried and rejected because of interference produced by transmission beam interaction with the scattered light. An interference filter with a nominal transmission of 0.10 at 6328Å was also rejected because of varying transmission across the surface, apparently due to substrate thickness variations.

A thin glass prism, with an apex angle of $\pi/90$ rad (2°), at the minimum deviation position was finally chosen. A 20 Å bandwidth interference filter in front of the detector intercepted almost all background light, while the detector sampled the high intensity light resulting from the double reflections of the system. The half-wave plate was adjusted to achieve maximum extinction in the deflected beam, and that position was marked as 0 rad. The output beam intensities were measured while the angle of the linearly polarized light leaving the plate was varied between 0 and $\pi/2$ rad. At the larger angle, almost all light was directed to the deflected beam.

With the arrangement in Figure 2, a beam ratio range of from 4.4×10^{-4} to 7.4×10^{3}, over seven decades, was available. With the arrangement in Figure 1, the range was extended to beyond 2×10^{8}. The ellipticity introduced into the laser beam by the mirror (Fig. 2) caused no appreciable difference between experimental results and expected values. In fact, for those applications involving mirror incidence angles that are non-varying as a function of time, the extra phase change may be considered a small, constant, optical path length difference which can often be ignored.

Reference:

Champagne, E. B., Ph.D.: dissertation, A Qualitative Study of Holographic Imaging, The Ohio State University, 1967. Available through University Microfilms, Ann Arbor, 1968.

Note:

Requests for further information may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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